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(54) OPTICAL ROTARY ENCODER

(57) An optical rotary encoder simple in construction and capable of easily securing an aligned state of a code plate with a rotating shaft. A disk DS and an attachment portion DM of a code plate (6) are formed of an integrated plastic molded product, so that the assembly work for the code plate (6) itself is unnecessary. A lens group is formed in a predetermined region of the disk DS. When a fitting portion RE of a shaft member (20) is press fitted into an insertion hole DE, alignment holding portions (J1 to J3) are deformed plastically to thereby achieve the alignment. The attachment portion DM and the shaft member (20) are fixed to each other by engaging a fixing bolt BL with threaded holes DH and RH. A plurality of alignment holding portions (K1 to K3) may be provided at the outer peripheral surface of the attachment portion DM. In this case, the alignment is achieved by press fitting the attachment portion DM into a fitted portion RF and plastically deforming the alignment holding portions (K1 to K3). The alignment holding portions may be provided so as to be deformed elastically in the radial direction. Also, a tapered fitting structure may be adopted.

FIG. 7a

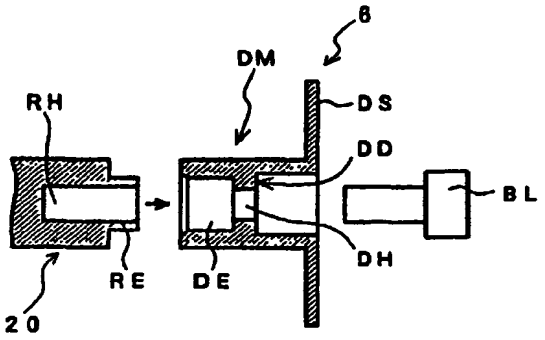
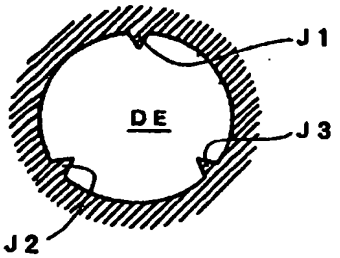


FIG. 7b



EP 0 927 873 A1

light emitted from the light emitting section is converted into the movable discrete beam, almost a half of the quantity of light has already been wasted, so that an efficient signal output cannot be obtained.

Problem 2: In order to form a light and shade lattice having the light transmitting portions and light intercepting portions on the code plate 1 and fixed slit 3, troublesome and costly processes such as chromium deposition, etching, and machining are needed, which increases the cost of the whole optical rotary encoder.

Problem 3: In order to attach the code plate to the rotating shaft member, a plurality of attaching portions continuous with the code plate is needed. It is actually difficult to configure the attaching portions integrally (as one member) with a body portion (disk member) of the code plate, so that the whole code plate is made up of two or three members. For this reason, the code plate is easily affected by errors of fabrication accuracy and assembly accuracy of these parts,. especially the alignment accuracy for alignment with the shaft member. Also, the burden of assembly work for decreasing these errors is heavy.

[0010] FIGS. 3a to 3d show code plates of the conventional optical rotary encoder. FIGS. 3a and 3b show an example of code plate made up of two members, and FIGS. 3c and 3d show an example of code plate made up of three members.

[0011] In the example of code plate made up of two members as shown in FIGS. 3a and 3b, a disk DS constituting the body portion of the code plate 1 is joined to a collar portion HL of a hub HB serving as an attaching portion to a shaft member (not shown). As the material of the disk DS, glass is used. In the region indicated by hatching in the front view, a code element (lattice pattern of transmitting portions and intercepting portions) as shown in FIG. 2 is formed by chromium deposition or the like. Also, the hub HB including the collar portion HL is made of a metal such as aluminum or brass, and an adhesive AD suitable for bonding of metal to glass is used for the joining of the collar portion HL.

[0012] The hub HB has a hollow construction, and as shown in the front view, a screw hole SH engaging with a fixing bolt (not shown), an edge portion HG, and an inner peripheral step portion HD are provided.

[0013] In the example of code plate made up of three members as shown in FIGS. 3c and 3d, a disk DS constituting the body portion of the code plate 1 is lapped on a collar portion HL of a hub HB serving as an attaching portion to a shalt member (not shown), and locked reinforcingly with a washer WS. As the material of the disk DS, metal is used, and in the region indicated by hatching in the front view, a code element (lattice pattern of transmitting portions and intercepting portions) as shown in FIG. 2 is formed by metal etching or the like. Also, the hub HB including the collar portion HL is made of a metal such as aluminum or brass.

[0014] As is the case of code plate made up of two members, the hub HB has a hollow construction, and as shown concentrically with the washer WS in the front view, a screw hole SH engaging with a fixing bolt (not shown), an edge portion HG, and an inner peripheral step portion HD are provided.

[0015] Thus, neither of the constructions shown in FIGS. 3a and 3b and FIGS. 3c and 3d are an integral construction in which the disk DS constituting the body portion of the code plate 1 is integral with the hub HB serving as an attaching portion. Therefore, when the disk DS is assembled to the hub HB (joining using adhesive, locking using washer), it is not easy to secure the alignment relationship (aligned state) between them. As a result, measures are taken such that alignment is performed with a heavy burden when the encoder is assembled, or faulty products are rejected in the inspection process at the sacrifice of a low yield.

[0016] The inventor of the present invention has made a proposal for solving problems 1 and 2 of the above problems 1 to 3 (PCT/JP98/00726). According to this proposal, a code plate using a lens element group arranged periodically is used as a means for converting the stationary beam from the light emitting section into a movable discrete beam group.

[0017] FIGS. 4a, 4b and 5 are views for illustrating one example of a code plate used in the aforementioned improvement proposal. In FIGS. 4a and 4b, a sectional view and a front view of an improved code plate denoted by reference numeral 6 are drawn, respectively, in a simplified form. The code plate 6 is provided with many lens elements 61 arranged periodically with a predetermined pitch in the circumferential direction. The lens element 61, which plays a role of movable slit (generation of movable discrete beam group) in the conventional code plate, is formed on one surface or both surfaces of the code element. By the rotation of the rotating shaft member 2 connected to a rotor shalt of motor or the like, these lens elements 61 are rotated around a center axis S.

[0018] FIG. 5 is a view for illustrating a generating operation of a movable discrete beam group in the case where the code plate 6 is used, in the same form as that of FIG. 2. The code plate 6 shown in this figure is made of a plastic such as acrylic resin and polycarbonate, and formed with many convex lens elements 61 on the light outgoing side thereof The condensing power (refracting power) of each lens element 61 is designed so that the beam width of a movable beam MF is decreased to a half of the reference pitch IP when the movable beam MF reaches the light receiving device 42. Between the movable beams MF are formed shadow regions SD where the light does not pass through.

[0019] When the rotating shaft 2 of the code plate 6 connected to a rotor of motor or the like rotates, the code plate 6 is rotated, so that the rotational position of

Brief Description of Drawings

[0030]

FIG. 1 is a view for illustrating a basic construction of an optical detection section by taking a rotary type optical rotary encoder as an example;
FIG. 2 is a view showing a general cross-sectional construction of a code plate (movable slit), fixed slit, and light receiving section used in the construction shown in FIG. 1;
FIGS. 3a to 3d show assembly constructions of conventional code plates, FIG. 3a being a side view of a code plate made up of two members, FIG. 3b being a front view thereof, FIG. 3c being a side view of a code plate made up of three members, and FIG. 3d being a front view thereof;
FIG. 4a is a side view showing the outline of a plastic code plate used for a rotary encoder, and FIG. 4b is a front view thereof;
FIG. 5 is a view for illustrating the generating operation of a movable discrete beam group in the case where a plastic code plate is used;
FIGS. 6a and 6b show a configuration of a principal portion of a first embodiment of the present invention, in the same form as that of FIGS. 3a to 3d, FIG. 6a being a sectional view of an integrally molded code plate, and FIG. 6b being a simplified front view showing an appearance of the code plate;
FIG. 7a is a sectional view showing a configuration of a principal portion of a second embodiment of the present invention, FIG. 7b shows alignment holding portions provided in an insertion hole, FIG. 7c is a sectional view showing a configuration of a principal portion of a third embodiment, and FIG. 7d shows alignment holding portions provided at an attachment portion;
FIGS. 8a to 8h are views for illustrating several other examples of alignment holding portions;
FIG. 9a is a sectional view showing a configuration of a principal portion of a fourth embodiment of the present invention, and FIG. 9b is a sectional view showing a configuration of a principal portion of a fifth embodiment;
FIG. 10a is a sectional view for illustrating an example in which an adhesive is used to fix a shaft member to an attachment portion, as a sixth embodiment; FIG. 10a being a sectional view before assembly, and FIG. 10b being a sectional view after assembly and fixing;
FIG. 11 is a sectional view showing an example of a lens element group formed on a code plate;
FIG. 12 is a sectional view showing another example of a lens element group formed on a code plate; and
FIG. 13 is a sectional view showing still another example of a lens element group formed on a code plate.

Best Mode of Carrying out the Invention

[0031] FIGS. 6a and 6b show a configuration of a principal portion of a first embodiment of the present invention, in the same form as that of FIGS. 3a to 3d. FIG. 6a is a sectional view of an integrally molded code plate, and FIG. 6b is a simplified front view showing an appearance of the code plate. As shown in FIGS. 6a and 6b, a disk DS constituting a body portion of a code plate 6 and an attachment portion DM to a shalt member 20 are formed of an integrally molded plastic product manufactured by, for example, injection molding.

[0032] Although the details are omitted in these figures, a lens group LS of an irregular shape is formed in the hatched portion of the disk DS in the front view. The forming mode (irregular shape and arrangement) and operation of the lens group LS are as explained, for example, with reference to FIGS. 3 and 4, but many other variations are available. These examples are described later.

[0033] The attachment portion DM formed concentrically with the disk DS has an insertion hole DE having an inside diameter equal to the outside diameter of a fitting portion RE of a shaft member 20 of a rotating shalt, and further has a threaded hole DH concentrically continuing with the insertion hole DE. The diameter of the threaded hole DH is designed so as to be smaller than the inside diameter of the insertion hole DE using a step portion DD. On the side of the shaft member 20, on the other hand, a threaded hole RH is formed concentrically with the fitting portion RE.

[0034] Thus, the code plate 6 is made up of one member, so that the assembly work for the code plate 6 itself is unnecessary, and therefore an error caused by the assembly work does not occur. That is to say, by increasing the molding accuracy of the code plate 6, the concentric relationship between the disk DS and the attachment portion DM can be secured. The alignment in installing the disk plate 6 to the shaft member 20 is performed through an operation of inserting the fitting portion RE of the shaft member 20 into the insertion hole DE, whereby the concentric relationship between the disk plate 6 and the shaft member 20 is secured.

[0035] FIGS. 7a and 7b are a sectional view showing a configuration of a principal portion of a second embodiment of the present invention and a view for illustrating alignment holding portions, respectively. FIGS. 7c and 7d are a sectional view showing a configuration of a principal portion of a third embodiment of the present invention and a view for illustrating alignment holding portions, respectively. The second embodiment shown in FIGS. 7a and 7b has almost the same construction as that of the first embodiment except that alignment holding portions J1 to J3 are provided on the inner periphery of the insertion hole DE of the attachment portion DM of the code plate 6. Specifi-

denoted by reference characters L1 to L3, M1 to M3, N1 to N3, and O1 to O3 are examples in which protrusions capable of being deformed plastically in the radial direction are provided on the inner peripheral surface of the insertion hole DE in a form of extending in the circumferential direction. In the leftmost example in which the alignment holding portions are denoted by reference characters L1 to L3, the position of the outer periphery of the fitting portion RE is indicated by the broke line to which reference character Z1 is applied. Also, alignment holding portions denoted by reference characters P1 to P3, Q1 to Q3, R1 to R3, and S1 to S3 are examples in which protrusions capable of being deformed plastically in the radial direction are provided on the outer peripheral surface of the attachment portion DM in a form of extending in the circumferential direction. In the leftmost example in which the alignment holding portions are denoted by reference characters R1 to R3, the position of the inner periphery of the fitted portion RF is indicated by the broken line to which reference character Z2 is applied.

[0046] When the former alignment holding portions L1 to L3, M1 to M3, and N1 to N3 are used, the alignment in installing the disk plate 6 to the shaft member is achieved by a radial elastic deformation of the alignment holding portions L1 to L3, M1 to M3, N1 to N3, and O1 to O3 through an operation of inserting (press fitting) the fitting portion RE of the shaft member into the insertion hole DE, whereby the concentric relationship between the disk plate 6 and the shaft member 20 is secured.

[0047] On the other hand, when the latter alignment holding portions P1 to P3, Q1 to Q3, R1 to R3, and S1 to S3 are used, the alignment in installing the disk plate 6 to the shaft member is achieved by a radial elastic deformation of the alignment holding portions P1 to P3, Q1 to Q3, R1 to R3, and S1 to S3 through an operation of inserting (press fitting) the attachment portion DM into the fitted portion RF on the shaft member side, whereby the concentric relationship between the disk plate 6 and the shaft member 20 is secured.

[0048] In both cases, the fixing bolt BL is engaged with the threaded hole DH and the threaded hole RH in a state in which the concentric relationship is secured, whereby the disk plate 6 can be fixed to the shaft member 20.

[0049] FIG. 9a is a sectional view showing a configuration of a principal portion of a fourth embodiment of the present invention, and FIG. 9b is a sectional view showing a configuration of a principal portion of a fifth embodiment.

[0050] The fourth embodiment shown in FIG. 9a is characterized in that the inner periphery of the insertion hole DE of the attachment portion DM of the code plate 6 and the outer periphery of the fitting portion RE of the shaft member 20 consist of tapered surfaces DQ and RQ which fit to each other, respectively. Other configurations are the same as those of the first embodiment, so that the repeated explanation is omitted.

[0051] In this embodiment as well, as in the case of the first embodiment, the code plate 6 is made up of one member, so that the assembly work for the code plate 6 itself is unnecessary, and therefore an error caused by the assembly work does not occur. That is to say, by increasing the molding accuracy of the code plate 6, the concentric relationship between the disk DS and the attachment portion DM can be secured. The alignment in installing the disk plate 6 to the shaft member 20 is achieved by an operation of inserting the fitting portion RE of the shaft member 20 into the insertion hole DE while using the tapered surfaces DQ and RQ as guide means, whereby the concentric relationship between the disk plate 6 and the shaft member 20 is secured. The fixing bolt BL is engaged with the threaded hole DH and the threaded hole RH in a state in which the concentric relationship is secured, whereby the disk plate 6 is fixed to the shaft member 20.

[0052] On the other hand, the fifth embodiment shown in FIG. 9b is characterized in that the outer periphery of the attachment portion DM of the code plate 6 and the inner periphery of the fitted portion RF of the shaft member 20 consist of tapered surfaces DP and RR which fit to each other, respectively. Other configurations are the same as those of the first embodiment, so that the repeated explanation is omitted.

[0053] In this embodiment as well, the code plate 6 is made up of one member, so that the assembly work for the code plate 6 itself is unnecessary, and therefore an error caused by the assembly work does not occur. Thereupon, by increasing the molding accuracy of the code plate 6, the concentric relationship between the disk DS and the attachment portion DM can be secured.

[0054] The alignment in installing the disk plate 6 to the shaft member 20 is achieved by an operation of inserting the attachment portion DM of the disk 6 into the fitted portion RF of the shaft member 20 while using the tapered surfaces DP and RR as guide means, whereby the concentric relationship between the disk plate 6 and the shaft member 20 is secured. The fixing bolt BL is engaged with the threaded hole DH and the threaded hole RH in a state in which the concentric relationship is secured, whereby the disk plate 6 is fixed to the shaft member 20.

[0055] In the embodiments explained above, a fixing bolt has been used to fix the attachment portion and the shaft member to each other in a state in which one of these elements is fitted to the other. However, an adhesive can be used. FIG. 10a is a sectional view for illustrating an example in which an adhesive is used, as a sixth embodiment. FIG. 10a is a sectional view before assembly, and FIG. 10b is a sectional view after assembly and fixing.

[0056] As shown in FIG. 10a, the disk DS constituting the body portion of the code plate 6 and the attachment portion DM to the shaft member 20 are formed of an integrally molded plastic product manufactured by, for

rotating shaft is secured. Therefore, there is provided a high-quality and less-costly optical rotary encoder which is simple in construction and easy in manufacture.

Claims

1. An optical rotary encoder comprising a light emitting section, a code plate for converting light supplied from said light emitting section into a discrete movable beam group and a light receiving section for receiving light contained in said discrete movable beam group, for detecting rotation amount or rotational speed of a rotating shaft based on signals obtained from said light receiving section,
wherein said code plate has a body portion and an attachment portion, said code plate is held concentrically by a shaft member constituting said rotating shaft through said attachment portion, and said body portion and said attachment portion are formed of an integrated plastic molded product.

2. An optical rotary encoder according to claim 1, wherein a fitting and holding mechanism for fitting and holding said attachment portion and said shaft member to each other is provided for performing the concentric holding.

3. An optical rotary encoder comprising a light emitting section, a code plate for converting light supplied from said light emitting section into a discrete movable beam group and a light receiving section for receiving light contained in said discrete movable beam group, for detecting rotation amount or rotational speed of a rotating shaft based on signals obtained from said light receiving section,
wherein said code plate has a body portion and an attachment portion, said code plate is held concentrically by a shaft member constituting said rotating shaft through said attachment portion, said body portion and said attachment portion are formed of an integrated plastic molded product, and said optical rotary encoder further comprises alignment holding means for performing the concentric holding of said code plate in alignment with said rotating shaft.

4. An optical rotary encoder according to claim 3, wherein a fitting and holding mechanism for fitting and holding said attachment portion and said shaft member to each other is provided for performing the concentric holding.

5. An optical rotary encoder according to claim 4, wherein said fitting and holding mechanism includes an alignment holding portion plastically deformable and provided on at least one of an outer periphery and an inner periphery of said attachment portion, and said alignment holding portion is plastically deformed in radial direction when said attachment portion and said shaft member are fitted to each other, thereby the alignment of said code plate with said rotating shaft is performed.

6. An optical rotary encoder according to claim 4, wherein said fitting and holding mechanism includes an alignment holding portion elastically deformable and provided on at least one of an outer periphery and an inner periphery of said attachment portion to extend in circumferential direction, and said alignment holding portion is elastically deformed in radial direction when said attachment portion and said shaft member are fitted to the other, thereby the alignment of said code plate with said rotating shaft is performed.

7. An optical rotary encoder according to claim 4, wherein said fitting and holding mechanism includes tapered surfaces formed on both of said attachment portion and said shaft member, and the alignment of said code plate with said rotating shaft is performed by fitting operation to bring said tapered surfaces into contact with each other.

8. An optical rotary encoder according to claim 3 or 4, wherein said attachment portion and said shaft member are bonded to be fitted to each other in a state in which said attachment portion and said shaft member are fitted to each other.

9. An optical rotary encoder according to any one of claims 1 to 8, wherein said code plate comprises a plurality of lens elements arranged periodically in circumferential direction and light supplied from said light emitting section is converted into a discrete beam group by said plurality of lens elements.

FIG.3d

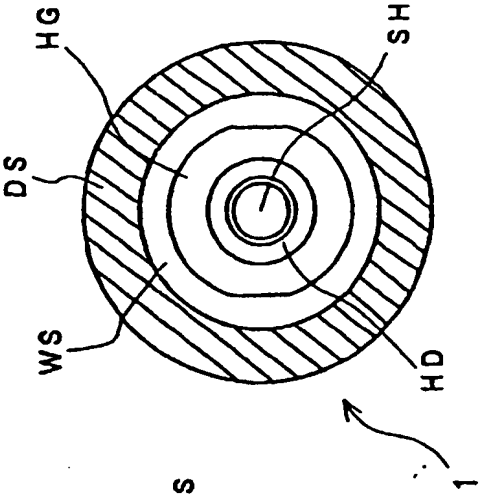


FIG.3c

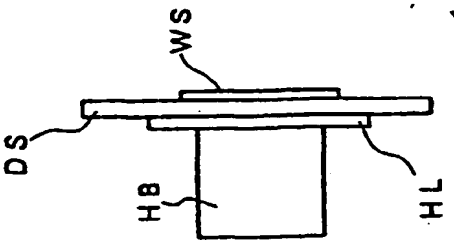


FIG.3b

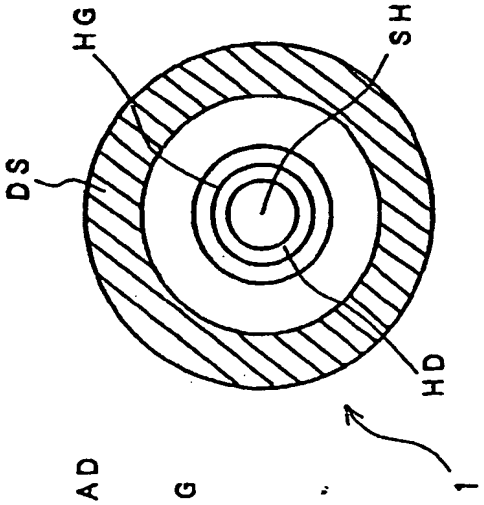


FIG.3a

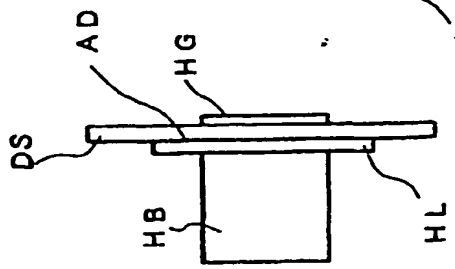


FIG. 5

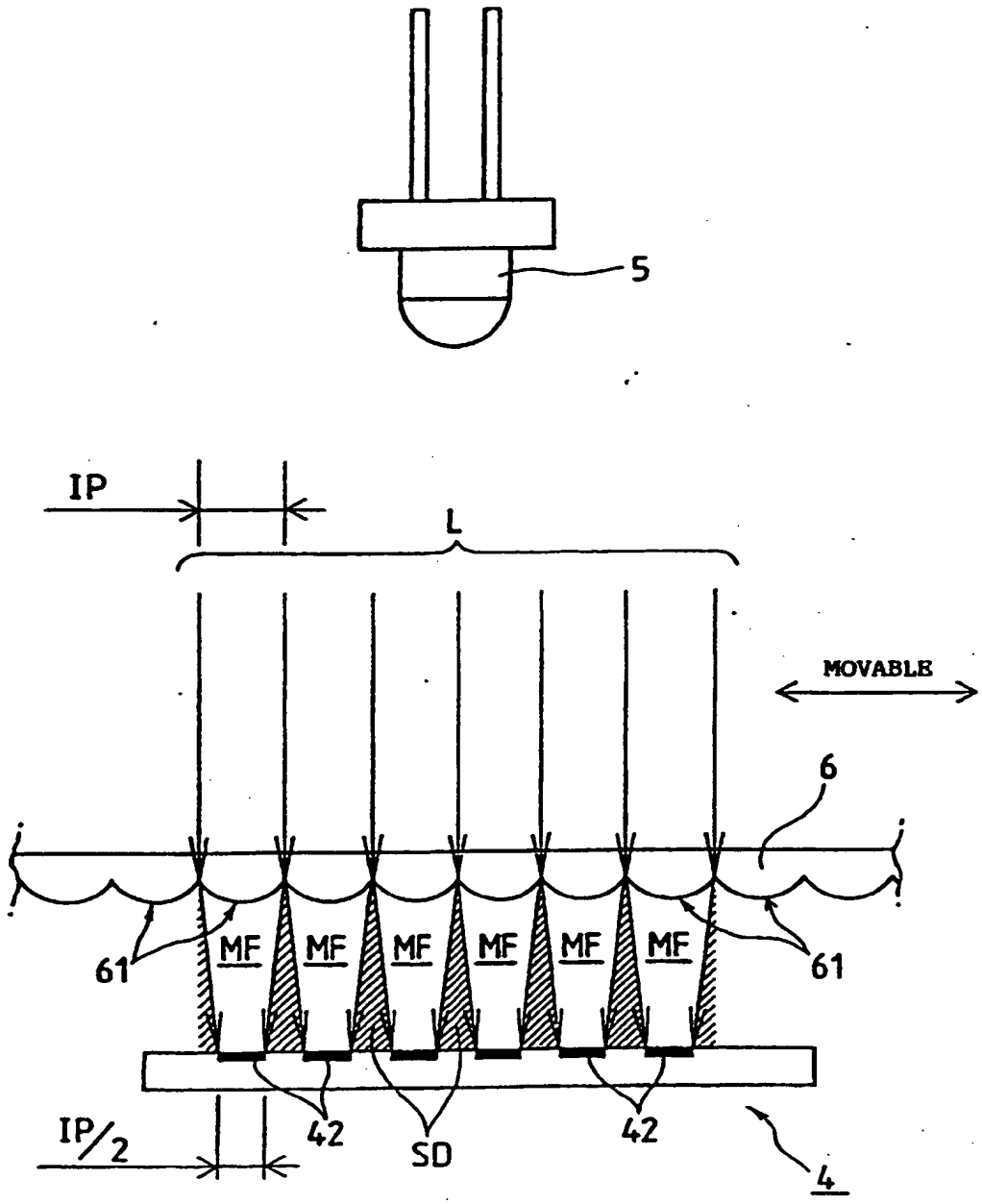


FIG. 7b

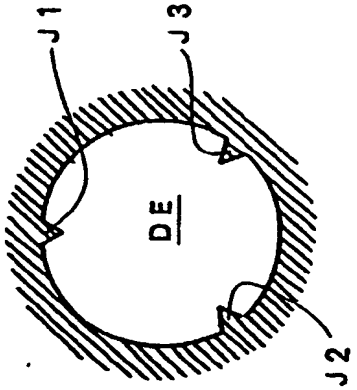


FIG. 7d

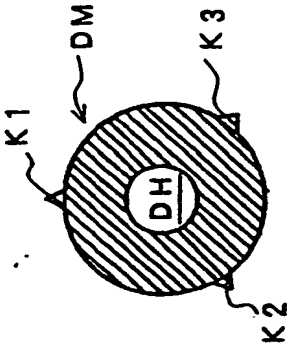


FIG. 7a

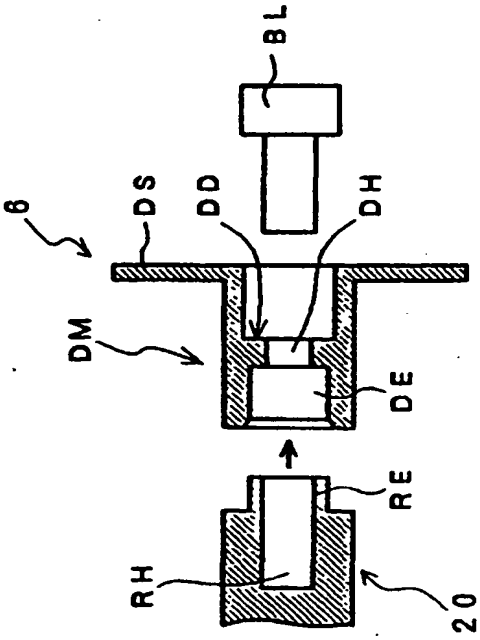


FIG. 7c

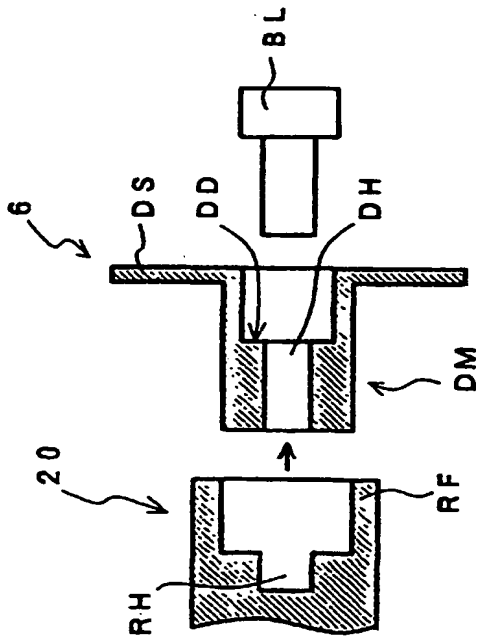


FIG. 9b

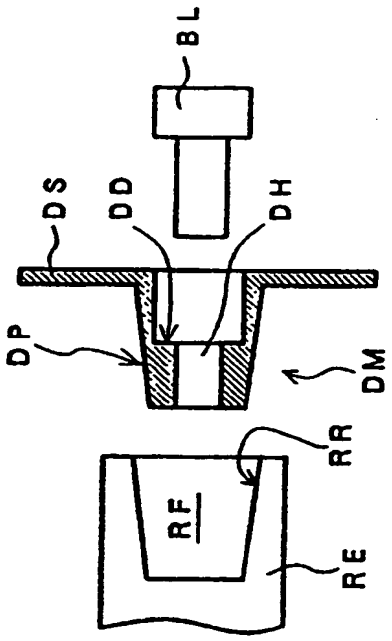


FIG. 9a

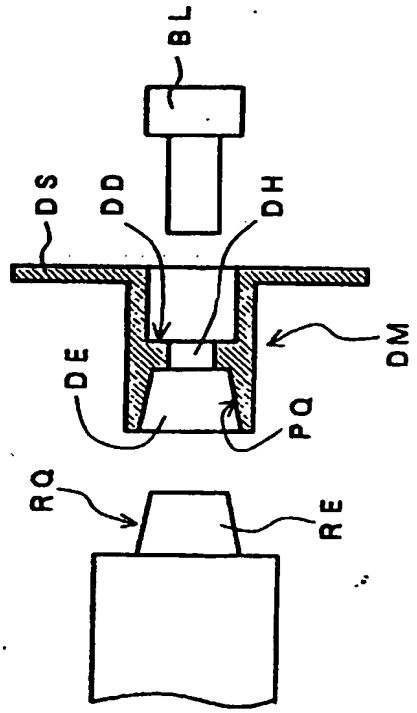
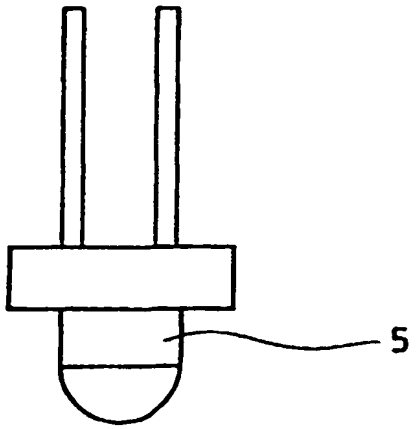


FIG. 11



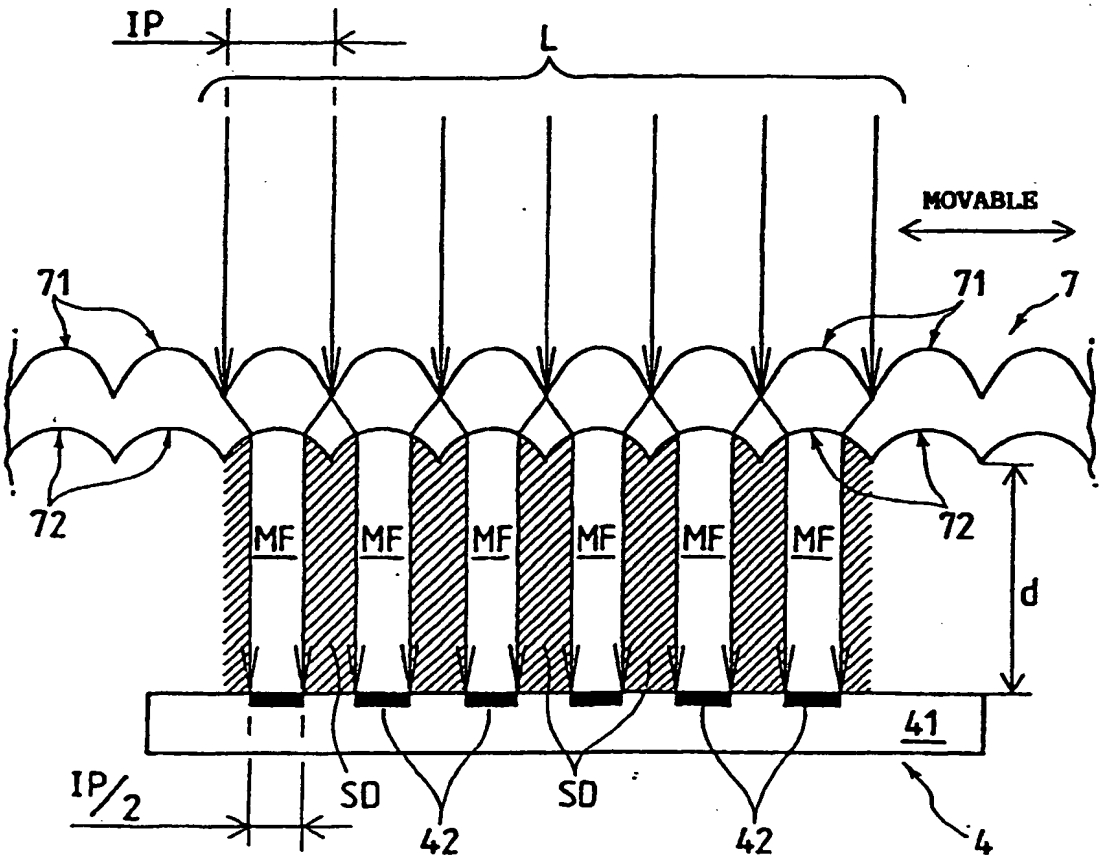
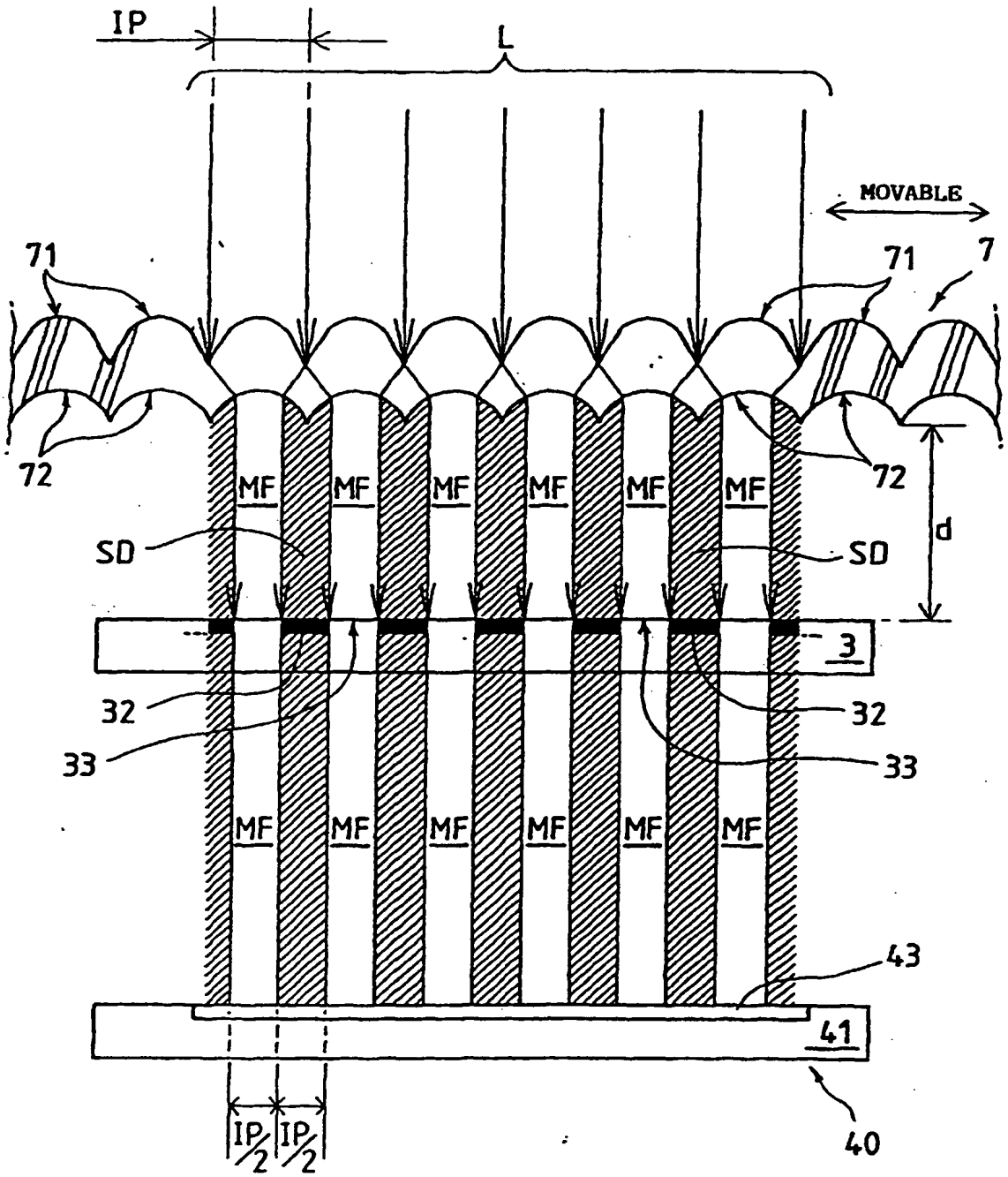


FIG. 13



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/02786

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 63-78021, A (Fujitsu Ltd.), April 8, 1988 (08. 04. 88), Page 2, lower right column, line 19 to page 3, upper left column, line 8 ; Fig. 3 (Family: none)	1-9
Y	JP, 61-246621, A (Seiko Epson Corp.), November 1, 1986 (01. 11. 86), Full text (Family: none)	1-9
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 179893/1987 (Laid-open No. 84015/1989) (Matsushita Electric Works, Ltd.), June 5, 1989 (05. 06. 89), Full text (Family: none)	1-4, 7, 8
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 150614/1989 (Laid-open No. 88120/1991) (Yaskawa Electric Mfg. Co., Ltd.), September 9, 1991 (09. 09. 91), Full text (Family: none)	1-4, 7, 8
Y	JP, 06-3160, A (Tokyo Electric Co., Ltd.), January 11, 1994 (11. 01. 94), Full text (Family: none)	5, 6
Y	JP, 05-296789, A (Matsushita Electric Industrial Co., Ltd.), November 9, 1993 (09. 11. 93), Full text (Family: none)	5, 6

Form PCT/ISA/210 (continuation of second sheet) (July 1992)